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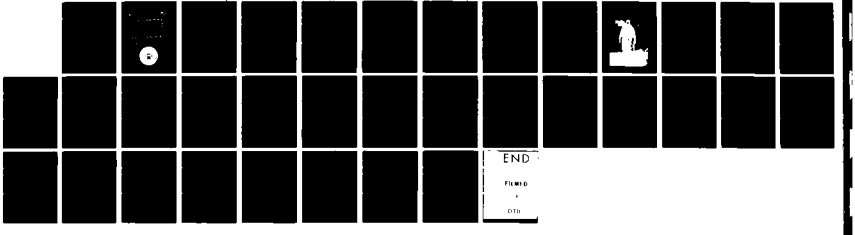

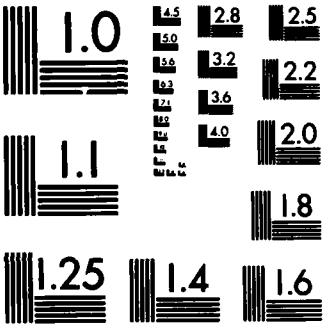

NAVY EXPERIMENTAL DIVING UNIT

DEPARTMENT OF THE NAVY
NAVY EXPERIMENTAL DIVING UNIT
PANAMA CITY, FLORIDA 32407

IN REPLY REFER TO:

NAVY EXPERIMENTAL DIVING UNIT

REPORT NO. 4-82

DRAEGER LAR V UNDERWATER BREATHING APPARATUS AND LIFE JACKET/BUOYANCY COMPENSATOR U.S. ARMY FIELD EVALUATION

R. W. DOWGUL

SEPTEMBER 1982

Approved for public release; distribution unlimited

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DRAEGER LAR V
SECUMAR LIFE JACKETS/BUOYANCY COMPENSATORS
U.S. ARMY FIELD EVALUATION

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

In support of the pending interservice agreement on diving equipments, testing of the DRAEGER LAR V closed-circuit oxygen underwater breathing apparatus (UBA) for U.S. Army mission compatibility and equipment inter-operability was conducted. The scope of this evaluation was to determine the suitability of the LAR V UBA for use by Army Special Warfare Forces (combat divers), and compatibility with their missions and equipments, by testing it under actual field conditions.

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The performance characteristics of the LAR V successfully supported all dive requirements under various conditions and with various ancillary equipment.

Divers comments indicate that the majority of users consider the DRAEGER LAR V to be an uncomplicated, easy to use and operate UBA. All divers considered the DRAEGER LAR V capable of supporting the Army combat diver and his mission.

Among all Life Jackets/BC's tested, the SECUMAR TSK 2/42 buoyancy compensator (BC) was determined to be the most compatible BC with the DRAEGER LAR V for the mission of the Army combat diver.

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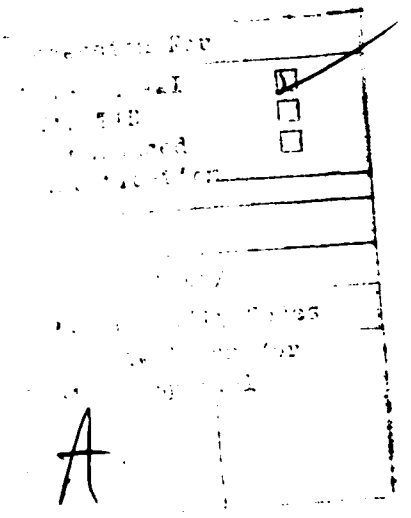

Glossary

BC	Buoyancy compensator
C/C	Closed-circuit
Canister breakthrough	Point at which CO_2 concentration in the inhaled gas reached 0.5 percent surface equivalent
MERADCOM	U.S. Army Mobility Equipment Research and Development Command
°C	Temperature in degrees centigrade
cmH_2O	Centimeters of water pressure
CO_2	Carbon dioxide gas
SFUWO	Special Forces Underwater Operation
°F	Temperature in degrees Fahrenheit
FSW	Feet-of-seawater
HP Sodasorb	High-performance sodasorb
NAVSEA	Naval Sea Systems Command
NEDU	Navy Experimental Diving Unit
O/C	Open circuit
O_2	Oxygen
psig	Pounds per square inch gauge
Kp/cm_2	Pressure, in Kilopound per square centimeter
UBA	Underwater breathing apparatus

Abstract

In support of the pending interservice agreement on diving equipments, testing of the DRAEGER LAR V closed-circuit oxygen underwater breathing apparatus (UBA) for U.S. Army mission compatibility and equipment inter-operability was conducted. The scope of this evaluation was to determine the suitability of the LAR V UBA for use by Army Special Warfare Forces (combat divers), and compatibility with their missions and equipments, by testing it under actual field conditions.

The performance characteristics of the LAR V successfully supported all dive requirements under various conditions and with various ancillary equipment.

Divers comments indicate that the majority of users consider the DRAEGER LAR V to be an uncomplicated, easy to use and operate UBA. All divers considered the DRAEGER LAR V capable of supporting the Army combat diver and his mission.

Among all Life Jackets/BC's tested, the SECUMAR TSK 2/42 buoyancy compensator (BC) was determined to be the most compatible BC with the DRAEGER LAR V for the mission of the Army combat diver.

I. INTRODUCTION

In support of the pending interservice agreement on diving equipments and the potential commonality of equipment, testing of the DRAEGER LAR V Closed-circuit Oxygen UBA for U.S. Army mission compatibility and equipment inter-operability was conducted. The purpose of this evaluation was to determine the suitability of the LAR V UBA for U.S. Army utilization, by testing it under actual field conditions. The effectiveness of the LAR V to adequately support an exercising diver has been determined by the Navy Experimental Diving Unit (NEDU) thru manned (reference 1) and unmanned (reference 2) testing. As a result of these tests, the Navy has been granted a waiver for one year (expiring 31 Dec 82) or until the LAR V is certified (reference 3), to use the system in operational missions. The LAR V is anticipated to replace or adjunct the MK 15 UBA presently used by Army Special Warfare Forces; therefore, evaluations of the LAR V for use by Army combat divers in a variety of missions was required. In accordance with the pending Joint Services Agreement mentioned above, NEDU was tasked by the U.S. Army Mobility Equipment Research and Development Command (MERADCOM) to conduct the required testing.

This effort consisted of test and evaluation of the LAR V under actual field conditions determining the suitability of the LAR V for use by Army Special Warfare Forces (combat divers), and compatibility with their missions and equipments. The tests were performed at NEDU in Panama City, Florida and at the Special Forces Underwater Operations (SFUWO) School, Key West, Florida. NEDU provided two LAR V's, related life jackets and BC's for these tests. Various types of life preservers/BC's were tested and evaluated in conjunction with the LAR V to determine the best life preserver or BC for use with the LAR V for specific missions. Life preservers/BCs tested included the BCM, MK 3, MK 4, SCUBAPRO 21-099-000, PARKWAYS VES-23121, and those recommended by DRAEGER (SECUMAR models TSK 34, TSK 2/42, TSK 47, and TSK 21). Preliminary functional testing of the life jackets was conducted at NEDU to evaluate their safety prior to field utilization. APPENDIX D outlines testing and results of NEDU Life Jacket/BC evaluation.

II. LAR V EQUIPMENT DESCRIPTION

A diver wearing the LAR V is shown in Figure 1.

The functional description of the DRAEGER LAR V is illustrated in Figure 2. From the O_2 cylinder (1), high-pressure O_2 passes through the cylinder on/off valve (2) to the pressure reducing regulator (3) where the high-pressure gas is reduced to a working pressure of 66 psig over-bottom setting, then piped to the demand regulator (4) which is adjustable from 10 to 30 cmH_2O. High-pressure gas is also piped to the 0 to 300 kp/cm^2 (0 to 4410 psig) pressure gauge located on top of equipment case housing. The demand regulator, secured to the equipment case housing and fitted to the breathing bag (5), functions each time the bag is emptied on inhalation. On inhalation, the inhalation check valve (6) opens and the diver receives gas from the breathing bag. If not enough gas is available, the demand valve actuates, adding more oxygen to the system. As the diver exhales, the

FIGURE 1

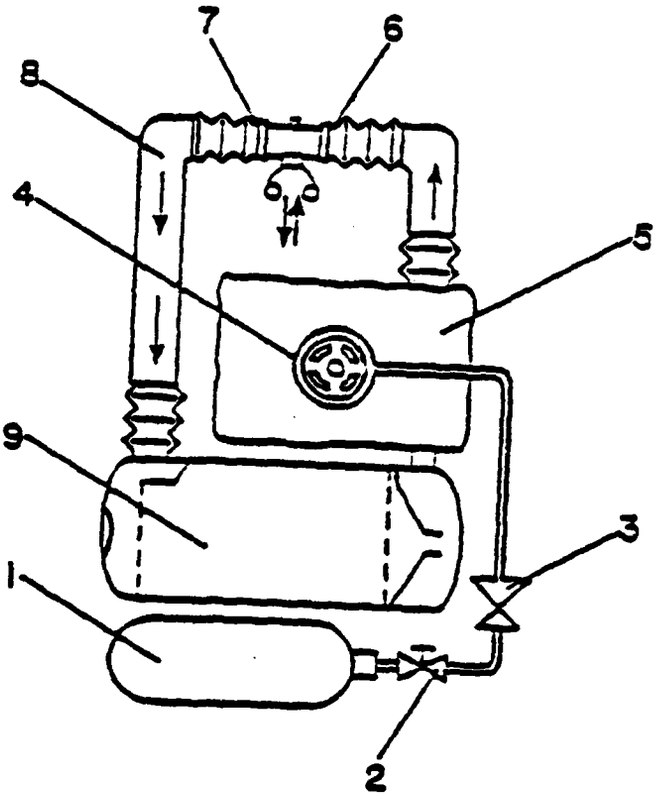

Figure 2. Functional Schematic

exhalation check valve (7) opens, the inhalation check valve closes and the exhaled gas flows through the exhalation hose (8) to the CO_2 scrubber; it is then filtered through the CO_2 scrubber (9) with the next inhalation. During descent, or to purge the unit, the diver merely depresses the demand bypass valve in the front center of the case housing.

III. LAR V SPECIFICATIONS

Dimensions: 11.8 in x 16.7 in x 6.7 in

Weight: 24.2 lbs

O_2 cylinder capacity: 10.6 ft^3 @ 3000 psig

CO_2 canister capacity: 5.0 lbs

Harness design: front mounted, neck and waist straps

Breathing bag volume: 6 liters

O_2 supply pressure gauge: mounted on top of case

Manual O_2 bypass valve: front mounted on case

Oxygen add system type: demand valve, automatically actuated

IV. TEST PROCEDURE

APPENDIX A provides the complete test plan.

A. After initial training and indoctrination (pool swims), open water swims were conducted. The distances of the swims were:

Distance (Meters)	Number of Dives
Pool	17
100	2
200	5
300	1
500	7
750	7
850	1
1000	29
1500	1

B. BC/Life Jacket. Various BCs and life jackets were utilized in conjunction with th LAR V during the above dives. The specific models used are as follows:

Model	Number of Dives
SECUMAR TSK 21	21
SECUMAR TSK 34	5
SECUMAR TSK 2/42	16
SECUMAR TSK 47	1
ARMY BCM	15
NAVY MK-3	1

C. Ancillary Equipment. Various equipments were utilized in conjunction with the LAR V in simulating actual missions during test dives. The equipments used were:

Item	Number of Dives
Compass Board	9
Wrist Compass	4
Depth Gauge	1
Dive Knife	3
Ruck Sack (with 50 to 65 lbs load)	18
German Waterproof Bag (with 60 to 80 lbs load)	4
Safety Buoy	1

D. Divers' Comments. Each diver was required to complete a test data sheet after each dive (APPENDIX B). The data sheet contained questions concerning dive profile, equipment used, and divers' past experience with similar closed-circuit rebreathers. In addition, the divers were asked to rate and comment on various aspects of the LAR V, such as, pre-dive preparation, donning equipment, and suitability/compatibility of the LAR V with mission and other equipment.

V. RESULTS

A. A total of 68 dives were conducted by 28 divers with a total dive (in-water) time of 1752 min (29.2 hrs).

1. During these dives there were 2 mission aborting failures; both were a result of operator error and inadequate pre-dive preparation. The problems encountered were due to loose fittings which resulted in leaks and flooding. Refer to APPENDIX C for a detailed account of both failures.

2. There were no equipment failures or deficiencies resulting in life support failures.

B. Equipment performance as rated by the divers.

1. Pre-Dive Preparation. When asked to rate the complexity of the LAR V pre-dive preparation, 4% (1 diver) considered it moderate with preparation time estimates of 30 minutes. None rated the preparation as complicated and 96% (27 divers) rated it as simple with time estimates ranging from 3 to 20 minutes.

2. Donning LAR V. In estimating the training and practice required in donning the LAR V none considered it extensive, 8% (2 divers) considered it moderate and 92% (26 divers) rated the training required as minimal.

3. Suitability/Compatibility of the LAR V with mission. (NOTE: The responses from all 68 dives are considered applicable for this evaluation.) No responses indicated that the LAR V was poor or inadequate for the performance of the combat diver's mission. During 22% (15 dives) of the dives it was rated as adequate, during 6% (4 dives) it was considered superior, and during 72% (49 dives) it was rated as excellent.

4. Suitability/Compatibility of the LAR V with ancillary equipment. (NOTE: During 15 dives, ancillary equipment was not utilized, this resulted in 53 applicable dives.) No responses indicated that the LAR V was poor or inadequate for utilization with ancillary equipments normally required by the combat diver. The LAR V was rated as adequate during 28% (15 dives), superior during 9% (5 dives) and excellent during 59% (31 dives). During one dive the diver felt that he required more training swimming the LAR V while carrying large loads (rucksacks, waterproof bags) and that excessive physical exertion should be avoided.

5. Post-Dive/Storage Requirements. None of the divers considered the post-dive cleaning and storage procedures of the LAR V to be extensive, 8% (2 divers) considered them moderate, and 92% (26 divers) thought the requirements minimal.

B. Cache. During this test effort, two LAR V UBA with fully charged oxygen (O_2) bottles and fully charged and fresh carbon dioxide (CO_2) absorbent canisters were cached in a secured area at 1 ATA (per APPENDIX A)

for a period of twenty-four hours prior to usage in a dive. These two LAR V UBA were then utilized during a 1000 meter swim at 15 FSW. No problems or discrepancies were encountered as a result of caching the UBA prior to usage.

VI. DISCUSSION

The functional performance of the LAR V was satisfactory throughout the entire range of testing as evidenced by the evaluation questionnaires required to be completed after each dive event. The following subjective comments are deemed appropriate regarding LAR V utilization by the U.S. Army:

A. Use in Airborne Operations. Use of the DRAEGER LAR V during airborne operations was not addressed but should be considered during any additional testing of the LAR V that may be required for Army application. This testing was not considered to be within the purview of NEDU's direction for test and evaluation of diving equipment in Army applications.

B. Safety. The DRAEGER LAR V was judged to present no serious hazard in operation. A life preserver or BC is required for all evolutions with the LAR V. It was noted that all Diver-Subjects preferred a BC over a CO_2 actuated life jacket for use with the LAR V. The use of a BC allowed the diver to adjust his position in the water column regardless of the ancillary equipment that was carried.

C. Transportability/Durability. The two LAR Vs used were transported more than 1500 miles over land during the course of this testing using their standard storage container. No difficulty was noted in the transportation and handling the UBAs, and no damage occurred as a result of handling during associated testing. Field testing demonstrated that the durability and compact design of the LAR V significantly enhanced its use by Army personnel in mission scenarios requiring overland/water interface.

D. BC/Life Jacket. Initial functional testing of all life jackets and BCs was conducted at NEDU (APPENDIX D). All life preservers and buoyancy compensators tested possessed adequate lift (26 to 40 lbs). However, all devices tested displayed a common undesirable feature of floating an unconscious diver (equipped with wet suit and no weight belt) in an attitude that resulted in his face being in the water. Divers preferred a buoyancy compensator over a life jacket. The use of a buoyancy compensator allowed the diver to adjust his buoyancy regardless of the ancillary equipment that he was carrying. NEDU Short Form Test Plan 82-19 test results (APPENDIX D) details the performance of selected BCs when dove with the LAR V.

E. Additional reliability data concerning documented dives with the LAR V was provided by the Navy Safety Center. Navy dives totaling 1200 hours without a life support failure are on record.

VII. CONCLUSIONS

A. The reliability demonstrated during this test further validates the U.S. Navy Safety Center's records referenced in Section VI, paragraph E of this report.

B. The LAR V is uncomplicated and easy to use based on diver comments regarding pre-dive preparations, donning and post-dive storage.

C. The LAR V successfully supported all dive requirements under all conditions when using various ancillary equipment as encountered during this testing.

D. Among all BC's tested, the SECUMAR TSK 2/42 BC was determined to be the most compatible BC with the DRAEGER LAR V for the mission of the U.S. Army combat diver.

E. The DRAEGER LAR V is capable of supporting the Army combat diver in his mission.

VIII. REFERENCES

1. NEDU Report 5-79, "Evaluation of Modifed DRAEGER LAR V Closed Cicuit Oxygen Rebreather," by J. Middleton and C. Piantadosi.

2. NEDU Report 3-82, "Unmanned Evaluation of Six Closed-Circuit Oxygen Rebreathers," by J. Middleton.

3. CNO Message 220330Z DEC 81.

APPENDIX A

DEPARTMENT OF THE NAVY
NAVY EXPERIMENTAL DIVING UNIT
PANAMA CITY, FLORIDA 32407

IN REPLY REFER TO:

NAVY EXPERIMENTAL DIVING UNIT

TEST PLAN - LONG FORM

DRAEGER LAR V Underwater Breathing Apparatus/Life Jacket
U.S. Army Field Evaluation

Test Number: 82-24

APRIL - AUGUST 1982

Prepared by:

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1. Test Title. DRAEGER LAR V UBA/Life Jacket U.S. Army Field Evaluation

2. Test Number. 82-24.

3. References

(a) NEDU Report No. 5-79.

(b) NEDU ltr Ser 385 dtd 18 Dec 81.

(c) NAVSEA ltr SEA-00C4 Ser 026 dtd 25 Jan 82.

(d) NEDU Report No. 1-82.

(e) CNO 220330Z DEC 81.

(f) NEDU Test No. 82-19

4. Introduction

In support of the pending interservice agreement on diving equipment and the potential commonality of equipment, testing of the DRAEGER LAR V Closed-circuit Oxygen UBA for U.S. Army mission compatibility and equipment inter-operability is herein outlined. The purpose of this evaluation is to determine the suitability of the LAR V UBA by testing it under actual field conditions. The effectiveness of the LAR V to support life has been determined by the Navy Experimental Diving Unit (NEDU) thru manned and unmanned testing. References (a), (b), (c) and (d) refer. As a result of these tests, the Navy has been granted a waiver for one year (expiring 31 Dec 82) (reference (e)), or until the LAR V is certified, to use the system in operational missions. The LAR V is anticipated to replace or adjunct the MK-15 UBA presently used by U.S. Army Special Warfare Forces; therefore, evaluation of the LAR V for use by Army combat divers in a variety of missions is required. In accordance with the pending Joint Services Agreement mentioned above, NEDU has been funded by the U.S. Army Mobility Equipment Research and Development Command (MERADCOM) to conduct the required testing.

This effort will consist of test and evaluation of the LAR V under actual field conditions to determine the suitability of the LAR V for use by Army Special Warfare Forces (combat divers), and compatibility with their missions and equipments. The tests will be performed at NEDU in Panama City, Florida and at the Special Forces Underwater Operations (SFUWO) School, Key West, Florida. NEDU will provide two LAR V and related DRAEGER life jackets for the test. Additionally, various types of life preservers/buoyancy compensators (BC) including the specified DRAEGER Life Jackets (Models # TSK 34, TSK 47 and TSK 21), MK 4, and other off-the-shelf life preservers (modified UDT, SAR-1), will be tested and evaluated in conjunction with the LAR V to determine the best life preserver for use with the LAR V for specific missions. Preliminary functional testing of the DRAEGER life jackets will be conducted at NEDU to evaluate their safety.

5. Program

a. Duration of tests: 30 days (the actual test days will be within a 4-month period as class schedules at SFUWO, KWEST permit).

b. Number of hours to be worked each test day: approximately 8.

c. Dates of test: 25 April through 12 August 1982.

6. Preliminary Arrangements

a. Two LAR V UBAs, life jackets and related spare parts are currently on hand at NEDU.

b. Testing will be carried out using existing NEDU (Panama City) and SFUWO (Key West) facilities.

7. Test Procedure

a. Initial testing will be conducted at NEDU to insure the safety of non-ANU/ASU life jackets/BCs to be utilized in conjunction with the LAR V (reference (f)).

b. Compass Swims. This test is intended to simulate operational applications/conditions. A minimum of 60 combined dives in the following modes will be completed:

NOTE

A Test Data Sheet must be completed for every dive.

	Minimum Number of Dives
(1) Distance:	
100 meters	10
500 meters	10
1000 meters	10
* Other Dives	30
	60
(2) Life Jacket/BC	
Army BCM	4
Navy Modified UDT	4
Navy MK-4	4
* Other Dives	48
	60

(3) Dive Platform

	Minimum Number of Dives
Shore	4
Pier	4
Small Boat (non-inflatable)	10
Rubber Boat (inflatable)	6
Aircraft	4
* Other Dives	32
	60

(4) Ancillary Equipment

None	6
Rucksack	6
Parachute	4
* Other Dives	44
	60

The above dive conditions may be met in any combination of distances, life jacket/BC, dive platform and ancillary equipment.

* The parameters/equipments specified for use during "Other Dives" are at the discretion of the test supervisor.

c. Cache. During this test effort, at a time specified by the Test Supervisor, a LAR V UBA with a fully charged oxygen (O_2) bottle and a fully charged and fresh carbon dioxide (CO_2) absorbent canister, will be cached for a period of not less than twenty-four hours immediately prior to usage in a dive.

In preparation for cache, the LAR V will undergo a routine pre-dive set-up. With the mouth bit in the "dive" position, the breathing circuit will be purged using the system O_2 bottle. The O_2 bottle valve will then be shut off and, while manually deflating the breathing bag, the mouthbit valve will be switched to the "standby" position. The entire LAR V will then be placed in a large plastic bag and sealed.

The test data sheet reporting the dive, in which the cached LAR V was used, will include comments in paragraph 22 indicating method, location and length of cache and any apparent consequence on the functioning of the subject LAR V.

This sequence will be repeated a minimum of four times during this test effort.

8. Post-Test Arrangements

a. After use in salt water, all equipment will be rinsed off with fresh water, air dried and stowed.

b. The Dive Supervisor is responsible for directing post-dive cleaning and storage of equipment and maintaining a maintenance log for the LAR V's and life jackets utilized.

c. At the conclusion of all testing, all equipment will be returned to NEDU.

9. Personnel

a. Test Supervisor: Mr. R.W. DOWGUL, NEDU Army Liaison.

b. Dive Supervisor/Subjects: personnel as available from NEDU and SFUWO.

10. Safety Rules and Precautions

a. All diving will be conducted under current procedures outlined in the U.S. Navy Diving Manual.

b. The Dive Supervisor will be responsible for pre- and post-dive procedures and arrangements.

c. O_2 exposure times at depth will be determined from TABLE 14-1 of the U.S. Navy Diving Manual.

11. Logistic Support Required

a. 2500 cubic feet of O_2 required.

b. 110 pounds of high performance SODASORB.

c. 30 ea. 38 gram CO_2 cartridges.

d. 4 sets of SCUBA for observation/safety dives.

e. NEDU and/or SFUWO diving boats and equipment for open-water dives.

12. Funding. Provided by MERADCOM (MIPAR) tasking funds.

13. Report Production. Upon completion of this test program, a report will be prepared by Mr. R.W. DOWGUL.

14. Comments

a. The testing schedule will be flexible in order to accomodate primary duties (training) at SFUWO, KWEST.

b. Army divers will be utilized in this test as available. Every effort will be made to involve as many Army units/personnel as possible.

c. The Airborne Board at Ft. Bragg, NC, is invited to observe, participate and comment as appropriate.

d. The actual number of dives may vary according to availability of facilities and personnel. Every effort will be made to exceed the required (minimum (60)) number of dives.

APPENDIX B

DRAEGER LAR V DIVE RECORD

TEST DATA SHEET

1. DATE: _____

2. DIVER'S NAME: _____

3. LAR V RIG NUMBER (CHECK ONE):

   ☐ # 1

   ☐ # 2

4. APPROXIMATE NUMBER OF PRIOR DIVES BY THIS DIVER UTILIZING THE LAR V (CHECK ONE):

   ☐ None

   ☐ 1 to 5

   ☐ 5 to 10

   ☐ OVER 10

5. APPROXIMATE NUMBER OF PRIOR DIVES BY THIS DIVER UTILIZING ANY CLOSED CIRCUIT UBA: _____ SPECIFY TYPE OF UBA: _____

6. LEAVE SURFACE TIME: _____

7. TOTAL BOTTOM TIME: _____

8. MAXIMUM DEPTH OF DIVE: _____

9. AIR TEMP: _____

10. WATER TEMP: _____

11. CURRENT IN KNOTS (SPECIFY DIRECTION OF CURRENT IN RELATION TO SWIM):

_____

12. VISIBILITY (IN FEET): _____

13. DISTANCE OF SWIM: _____

14. TYPE OF DRESS (CHECK ONE):

- ☐ "T" SHIRT
- ☐ DRY SUIT
- ☐ FULL WET SUIT

WET SUIT:

- ☐ TOP ONLY
- ☐ VEST ONLY
- ☐ OTHER (SPECIFY): _____

15. TYPE OF BUOYANCY COMPENSATOR/LIFE JACKET (CHECK ONE):

- ☐ U.S. ARMY BCM
- ☐ U.S. NAVY MK-4
- ☐ U.S. NAVY UDT-MODIFIED
- ☐ U.S. NAVY S.A.R.-1
- ☐ (DRAEGER) MODEL # TSK 34
- ☐ (DRAEGER) MODEL # TSK 47
- ☐ (DRAEGER) MODEL # TSK 21
- ☐ OTHER (SPECIFY): _____

16. DIVE PLATFORM (CHECK ONE):

- ☐ SHORE
- ☐ PIER
- ☐ SMALL BOAT (NON-INFLATABLE)
- ☐ RUBBER BOAT (INFLATABLE)
- ☐ AIRCRAFT (SPECIFY TYPE): _____
- ☐ OTHER (SPECIFY): _____

17. ANCILLARY EQUIPMENT UTILIZED IN CONJUNCTION WITH LAR V (CHECK ONE):

- ☐ NONE
- ☐ PARACHUTE
- ☐ RUCKSACK
- ☐ WEIGHT BELT (SPECIFY POUNDS): _____
- ☐ COMPASS BOARD
- ☐ OTHER (SPECIFY): _____

ANSWER THE FOLLOWING AND COMMENT, AS REQUIRED,
TO CLARIFY RESPONSE

18. HOW DO YOU RATE THE PRE-DIVE PREPARATION OF THE LAR V?

- ☐ COMPLICATED — ESTIMATE TOTAL PRE-DIVE SET-UP TIME: _____
- ☐ MODERATE
- ☐ SIMPLE

COMMENTS: _____

_____

_____

19. RATE THE DONNING OF THE LAR V (IN CONJUNCTION WITH ANCILLARY EQUIPMENT SPECIFIED IN 11 THRU 14); REQUIRES:

- ☐ EXTENSIVE TRAINING & PRACTICE
- ☐ MODERATE TRAINING & PRACTICE
- ☐ MINIMAL TRAINING & PRACTICE

COMMENTS: _____

_____

20 RATE THE SUITABILITY/COMPATIBILITY OF THE LAR V, AS DEMONSTRATED DURING THIS DIVE.

A. WITH MISSION:

☐ EXCELLENT

☐ SUPERIOR

☐ ADEQUATE

☐ POOR

☐ INADEQUATE

COMMENTS: _____

_____

_____

B. WITH ANCILLARY EQUIPMENT (AS SPECIFIED IN 11 THRU 14 ABOVE):

☐ EXCELLENT

☐ SUPERIOR

☐ ADEQUATE

☐ POOR

☐ INADEQUATE

COMMENTS: _____

_____

_____

21. RATE THE POST-DIVE/STORAGE REQUIREMENTS OF THE LAR V:

☐ EXTENSIVE

☐ MODERATE

☐ MINIMAL

COMMENTS: _____

_____

_____

22. RATE THE OVERALL COMPLEXITY AND DIVER LEVEL OF EFFORT IN UTILIZING THE LAR V UNDER THE CONDITIONS OF THIS DIVE; REQUIRES:

☐ EXTENSIVE TRAINING & PRACTICE

☐ MODERATE TRAINING & PRACTICE

☐ MINIMAL TRAINING & PRACTICE

COMMENTS: _____

_____

_____

23. LIST BELOW ANY ADDITIONAL COMMENTS, CONCLUSIONS, AND/OR RECOMMENDATIONS RELEVANT TO THE LAR V, INCLUDING ANY EQUIPMENT FAILURES OR DEFICIENCIES. (SPECIFY IF DIVE WAS ABORTED DUE TO EQUIPMENT PROBLEMS.)

_____

_____

APPENDIX C

FAILURES CAUSING DIVE ABORTS

Both DRAEGER LAR V systems used during these tests had been used during earlier tests at NEDU. Before these tests started, both LAR V systems underwent an in-house overhaul at NEDU. The LAR V systems were identified as Rig #1 and Rig #2.

Failure #1:

During the overhaul of Rig #1 an incorrect fitting was apparently installed at the breathing bag to canister connection. This resulted in a loss of the watertight integrity of the primary breathing loop. The subsequent leak and cause (incorrect fitting) were detected during the pre-dive preparation. After the proper fitting was installed no leaks were detected.

Failure #2:

With an accumulated bottom time of 360 minutes, at 39 minutes into the 14th dive of these series, involving Rig #2, the diver observed gurgling noises in his breathing system and increased breathing resistance. At this point the dive was aborted. A visual inspection of Rig #2 revealed water in the breathing loop. Further investigation (FIGURE 3 refers) disclosed a loose fitting (1) on the low pressure side of the high pressure oxygen regulator (2). This allowed water to enter the oxygen supply line to the demand valve (3). During activation of the demand valve at peak inhalation, the water passed through the supply line, demand valve and was introduced into the breathing bag (4). Simply tightening the loose fitting restored system watertight integrity. This leak should have been, but was not, detected during the pre-dive preparation of Rig #2.

It was determined that when mounting the oxygen (O_2) bottle and securing the rubber straps (6) some divers would pull the straps (6) around the bottle (5) and secure them in place. This is incorrect as it puts a twisting motion on the bottle (5) regulator (2) and fitting in question (1). Incorrect bottle mounting procedure resulted in loosening the fitting (1). The proper bottle mounting method is to pull the straps (6) down away from the case (7), stretching them. While holding the bottle (5) from twisting, pull the stretched strap (6) around the bottle (5) and secure it.

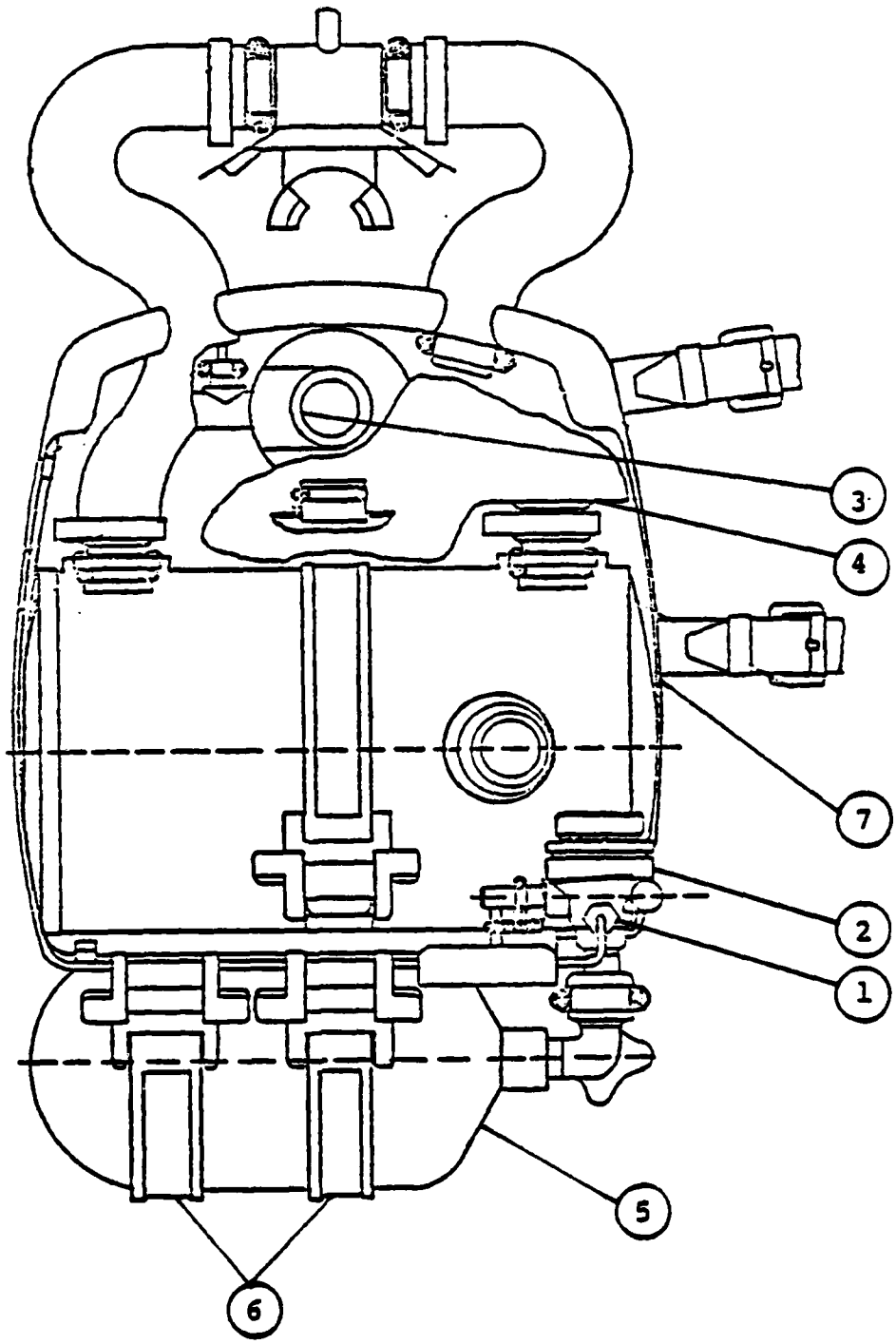

FIGURE 3

APPENDIX D

NAVXDIVINGUINST 3981.1G

DATE: 8 April 1982

NEDU TEST PLAN - SHORT FORM

All testing is to be performed following sound, safe diving practice in accordance with the U. S. Navy Diving Manual. The Dive Supervisor will be responsible for all pre- and post-dive arrangements. Sketches or special instructions will be attached to this test plan. List all equipment, including communications system, in item 10.

1. TEST TITLE: Draeger LAR V Life Jacket/Buoyancy Compensators.

2. REFERENCE: Draeger LAR V Evaluation for U.S. Army utilization.

3. PURPOSE: To determine the effectiveness and diver safety of the Draeger-compatible SECUMAR Life Jacket TSK 34; and Buoyancy Compensators, SECUMAR Models TSK 21, TSK 2/42 and TSK 47 SCUBAPRO Model 21-099-000 and Parkways BC Vest Model VES 23121 for use by combat swimmers.

4. TEST NUMBER: 82-19.

5. TEST DATE: April - July 1982.

6. BREATHING GAS SOURCE: 100% Oxygen.

7. WATER TEMPERATURE: Ambient.

8. TEST DESCRIPTION: See attachment.

9. REQUIRED SUPPORT: NEDU Test Pool, 1 O/C SCUBA for standby diver.

10. PROJECT OFFICER: LCDR BABER

DIVE SUPERVISOR: BMC(DV) DEARING

DIVE SUBJECTS: R. DOWGUL, LCDR BABER, SMC FERRAND, MR. MIDDLETON

11. EQUIPMENTS TO BE USED: DRAEGER LAR V, SECUMAR Life Jacket TSK 34, SECUMAR BC's TSK 21, TSK 2/42 and TSK 47, SCUBAPRO BC Model 21-099-000, and Parkways BC Vest Model VES 23121.

ORIGINATOR: RON DOWGUL, GS-13

REVIEWED: 02

03

04

05

01

APPROVED: 00

DISTRIBUTION: Codes 00, 01, 02, 03, 04, 05, 05A
ORIGINAL: Technical Library

NEDU Test Number: 82-19

The following tests simulate various operating conditions for the subject life preserver/buoyancy compensators (BC):

Test 1. Life Jacket, BC Surface Floating Attitudes

To determine which BCs will function as surface flotation for an unconscious diver (i.e., with diver's head completely out of water in order to breath), a series of buoyant ascents will be conducted with BCs partially inflated. In the 15-foot deep OSF Test Pool, two tests, each with a different bottom position assumed by the diver prior to ascent, will be performed with each BC to determine the effect of initial lift position upon surface floating attitudes. Each diver will wear a weight belt 20 pounds heavier than normally required. After the diver assumes a bottom position, his BC will be inflated to achieve neutral buoyancy, and the weight belt will be ditched. At this time he will go completely limp and remain that way until the surface floating attitude is recorded by a topside observer. Prior to ascent, the diver will assume a prone position for the first test, and a head-down/vertical position for the second test. These two bottom positions have been chosen to represent the normal position of an unconscious diver and the worst case condition to attain a face-up attitude on the surface, respectively.

The SECUMAR TSK 34 life jacket will be similarly evaluated for surface floating attitude by inflating the device for a buoyant ascent without ditching the weight belt (neutral buoyancy will not be achieved prior to ascent).

Test 2. BC Failure Modes

To determine possible effects on diver safety, BC failure modes will be evaluated in the OSF Test Pool. The purpose of these tests is to determine if a component failure or human engineering problem related to BC configuration can endanger the diver. The following parameters are evaluated:

a. L.P. Inflator Failing in the Open Position. A test will be conducted in which the L.P. inflator(s) (Air Cylinder(s)) will be turned to the full open position at 15 FSW. As the BC inflates, the exhaust valve will be held open to determine whether or not the BC can be adequately deflated to prevent uncontrolled ascent from excessive buoyancy.

b. Overpressure Relief Valve Flow Capability. The ability of each BC's overpressure relief valve to adequately handle maximum L.P. Inflator flow rates with a fully inflated BC will be evaluated. The purpose of this test is to determine whether the BC will rupture when fully inflated if the L.P. inflator failed in the open position.

c. Drain Plug Venting. (Applicable to SECUMAR Models TSK 21, TSK 2/42 and TSK 47 only.) The ability of gas/air supply to provide required buoyancy with both BC drain plugs removed will be evaluated. The purpose of this test is to simulate loss or accidental dislodgement of the drain plugs during a dive.

d. Human Engineering Evaluation of BC Controls. Tests will be conducted to evaluate ease of operating all BC controls. This includes operation of the following components (with wet and dry suit mitt-type gloves):

(1) L.P. Inflator Valve
(2) L.P. Inflator Hose Quick Disconnect Couplings (Parkways vest only)
(3) Exhaust Valve
(4) BC Harness Adjustment Fittings
(5) Oral Inflator

Test 3. BC Swim Characteristics

To evaluate surface and underwater swim characteristics, divers' comments will be recorded after tests 1 and 2. Divers will be instructed to evaluate rapid buoyant ascents.

Test 4. BC Buoyancy at 15 FSW

The purpose of this test series was to provide information on the BC lift capacity available to the diver for use as a tool and its ability to bring an unconscious diver up from the bottom. Each BC was attached to a spring scale anchored in 15 FSW, and fully inflated until the overpressure relief valve vented. The maximum upward force, or buoyancy, was measured in pounds of lift from the spring scale reading and recorded.

NEDU Test Number: 82-19

RESULTS

Equipment Description

The SECUMAR TSK 21, TSK 2/42 and TSK 47 BCs are similar in construction. All are "water wing" type jackets with waist and crotch straps. The obvious differences are that the TSK 21 has a black rubberized finish on the jacket, a "lock out" position on the manual dump valve and has one (1) high pressure air supply bottle (approx .21 liters & 200 bar). The TSK 2/42 and TSK 47 are olive drab in color and do not have the rubberized finish, or "lock out" position on the manual dump valve. The TSK 2/42 has two (2) high pressure air supply bottles (approx .47 liters & 200 bar each). Outside of the exceptions noted above the physical shape and size of TSK 21, TSK 2/42 and TSK 47 appear to be the same as the TSK 21.

The TSK 34 is similar in shape and material to the TSK 47, however, in lieu of a compressed air cylinder it utilizes a single 38 gram CO_2 cartridge. The life jacket is normally worn rolled up in a compact sheath that is fastened shut with velcro. When the CO_2 cartridge (non re-useable) is activated by pulling a lanyard, the jacket inflates automatically opening the carrying sheath by parting the velcro. The TSK 34 is also equipped with an oral inflation tube which can be used in lieu of the CO_2 cartridge.

The SCUBAPRO Model 21-099-000 BC is a direct copy of the physical shape of the SECUMAR TSK 47; however, two high presure air cylinders (approximately .75 litre and 200 bar each) are provided instead of one (as on the TSK 47), and there is a manual exhaust valve provided separate from the oral inflator assembly.

The PARKWAYS BC Vest Model VES 23121 is a commercially available item intended for use with conventional backpack mounted SCUBA bottles. It has no self-contained method for automatic inflation medium pressure; air is normally provided from the SCUBA first stage regulator. It was tested to determine the conceptual feasibility of utilizing a vest-type BC with the LAR V.

Test 1. BC, Life Jacket Surface Floating Attitudes

Surface floating attitudes were checked with and without the diver wearing a weight belt. All the SECUMAR and SCUBAPRO units floated the diver face down when used with a LAR V and wet suit but without a weight belt. When used with a LAR V wet suit and a weight belt, all these devices floated the diver face up. The PARKWAYS BC floated the diver face down under all conditions. Diver's position prior to ascent had no apparent effect on surface floating attitudes.

Test 2. BC, Life Jacket Failure Modes

Evaluation of various failure modes indicates no potential safety problems for divers properly trained with the flotation devices tested. Results of each test mode are:

a. LP Inflator Failing in the Open Position (BC's only). Tests showed that all BC's tested could be adequately vented to compensate for excessive inflator air flows.

b. Overpressure Relief Valve Flow Capability (BC's only). The overpressure relief valves prevented life jacket rupture on all BC's tested, by sufficiently venting excess air when fully inflated BC's received maximum air inlet flow.

c. Drain Plug Venting. All the SECUMAR BC's (TSK 21, 2/42 and 47) had the ability to maintain buoyancy with both drain plugs removed. However, when the diver is in the head-down position, additional air from the air supply bottle(s) is required to maintain buoyancy. Maintaining buoyancy in this position is limited by available air supply. The SCUBAPRO BC and the SECUMAR Model 34 life jacket are not equipped with drain plugs.

d. Human Engineering Evaluation of Life Jacket Controls. Operation of controls on all life jackets and BC's was adequate. However, the "lock out" feature on the TSK 21 manual dump valve could cause some reaction delay in an emergency situation.

Test 3. Swim Characteristics

All BCs and life jackets tested exhibited satisfactory swim characteristics. Very rapid ascents are possible with all of these devices and diver training should stress proper ascent procedures to prevent embolism.

Test 4. BC Buoyancy at 15 FSW

Pounds of upward force (buoyancy) exerted by each completely inflated life jacket and BC is listed in Table 1.

TABLE 1

MODEL	BUOYANCY (LBS)
TSK 21	34
TSK 2/42	33
TSK 47	32
TSK 34	40
SCUBAPRO 21-099-000	26
PARKWAY VES 23121	41

DISCUSSION:

Inspection of the SCUBAPRO MODEL 21-099-000 BC revealed markings indicating that the fabric of the BC was constructed in Mexico. The air cylinders have standard DIN fittings (metric threads), are rated at 200 bar, and have no DOT markings. This would imply that they are also of foreign manufacture.

Due to the type of mission that the DRAEGER LAR V is intended, and the probability that the LAR V dive would be carrying substantial quantities of ancillary equipment, the use of a BC is recommended over a life jacket. This would preclude the use of the SECUMAR TSK 34 with the LAR V.

The SECUMAR TSK 34 is a CO_2 actuated life jacket. Due to its configuration, the TSK 34 should be considered a flotation device and would not appear to be feasible for sub-surface buoyancy control during dives.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The PARKWAYS vest (model VES 23121) tested was not intended by the manufacturer for use with the DRAEGER LAR V. It did not float the diver in a head up attitude under any test conditions and is therefore unsatisfactory for use with the LAR V. The remaining life jacket and BC's tested were generally comfortable and well constructed. Proper training, prior to utilization, is essential for these flotation devices. The diver's weight belt must not be dumped prior to a buoyant ascent. During buoyant ascents precautions should be taken against embolism. Available air flows from the life jacket air supply cylinder can cause very rapid ascent if the control valve is not throtted properly.

RECOMMENDATIONS

It is recommended that the SECUMAR Models TSK-21, TSK 2/42, TSK 47 and SCUBAPRO Model 21-099-000 be field evaluated for interface/compatibility with the DRAEGER LAR V. The SCUBAPRO Model 21-099-000 has 19% less lift capability (ref. Table 1) than the next lowest rated SECUMAR BC, and may require modification prior to further testing.